Seminar Agenda

- Welcome and Introduction
- Operations Modeling Basics
- Operations Model Applications
- Q&A (Panel Discussion)
- Lunch
- Operations Modeling Tools
  - CALSIM II – Erik Reyes
  - HYDROPS – Tung Van Do
  - WQRSS – Carl Chen
  - HEC-RAS – Eric Clyde
- Next Steps

Local Operations Model for Oroville-Thermalito Complex

Tung Van Do (Powel Group, Inc.)

June 24, 2003

Overview

- Why Local Operations Model ?
- LOM's Basic Characteristics
- How does an optimization model work ?
- Oroville-Thermalito schematic
- LOM's Inputs
- LOM's Outputs
- LOM's Features
- Sample Screens

Why Local Operations Model ?

- CalSim II provides a bigger picture at monthly time steps
- LOM provides detailed analysis on hourly varying parameters
- LOM provides optimal hourly operation results for other analyses

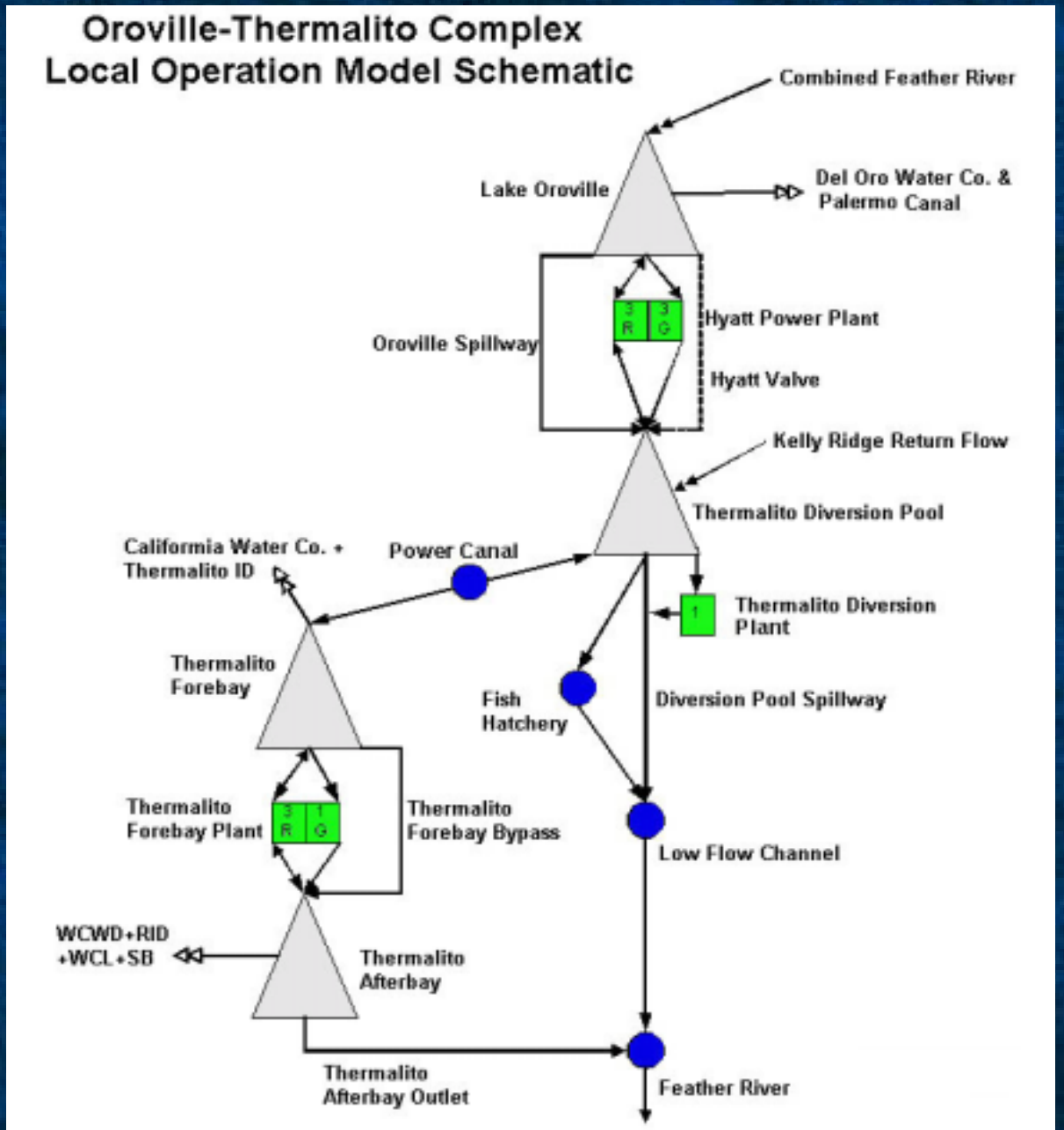
LOM (HYDROPS) Characteristics

- CALSIM II outputs are used for boundary conditions and targets
- Deterministic optimization model
- Basic parameters: flow, level, and generation
- Hourly time steps for weekly time horizon
- HYDROPS: a proprietary model

How does an optimization model work ?

- Objective: maximize or minimize something
- Constraints: X + 2Y < a, Y > b, etc.
- Starting and ending conditions
- Optimization techniques (LP, DP, etc.)

Oroville-Thermalito Schematic



LOM's Inputs

- Physical characteristics and limitations:
  - Reservoir, Power plant, Spillway, Canal, Turbines, etc.
- From CalSim II and others:
  - Inflow, diversion, and evaporation
  - Flood control curve (COE)
  - Flow and level targets
  - Energy price
- Operating constraints:
  - Operating min/max for basic parameters
  - Stage and flow fluctuation and ramping
  - Instream flow and licensing restrictions

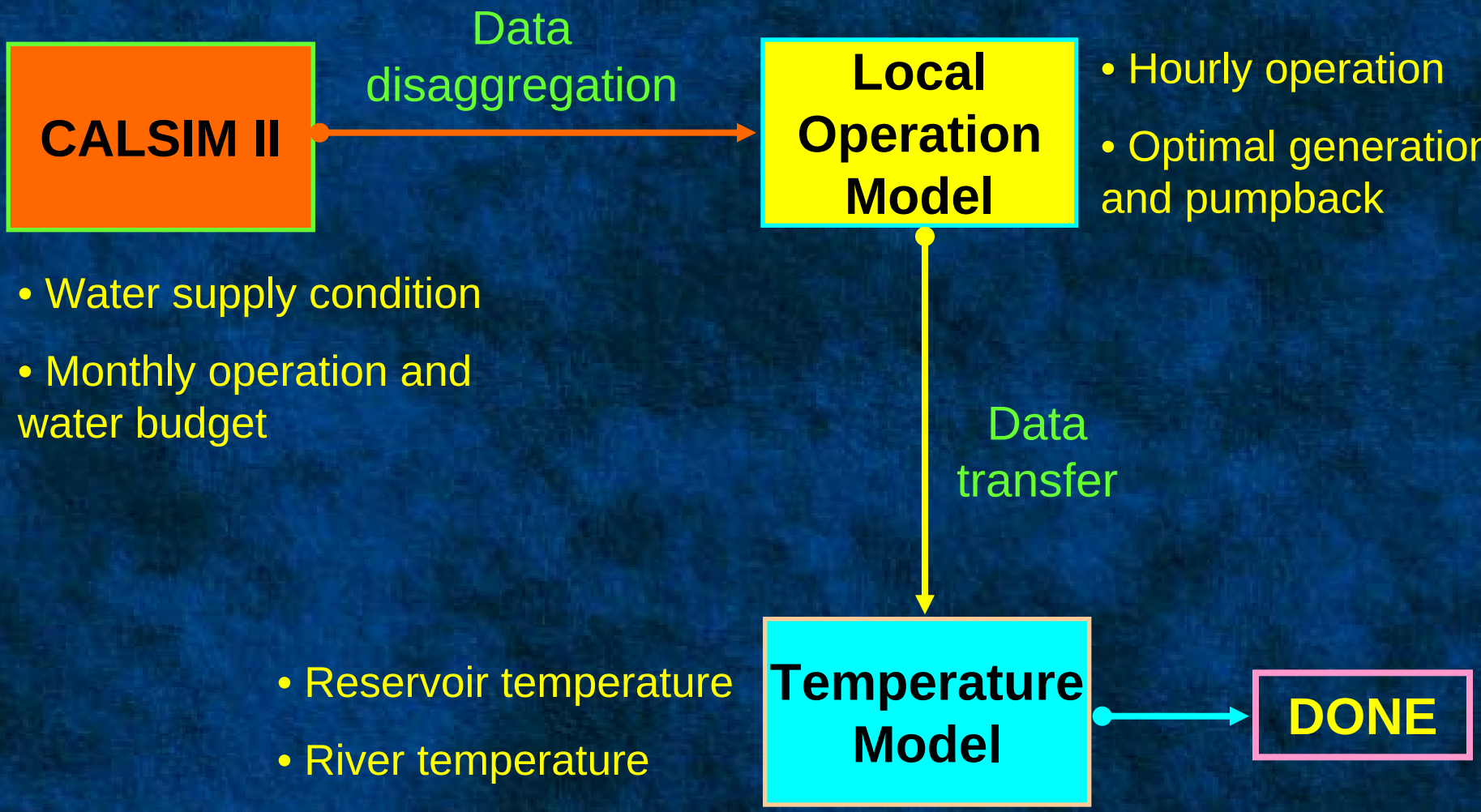
LOM's Outputs

- Hourly results:
  - Level and storage for all reservoirs
  - Generating and pump-back flow for all turbines and plants
  - Generation and pumping energy for all turbines and plants
  - Reservoir spill, Hyatt valve and Feather River flows
  - Generation and revenue for the system and for all plants
- Weekly results:
  - System and plant generation and revenue
  - Reservoir level, river flow, plant discharge and spill

LOM (HYDROPS) Features

- Scenario and Version Concept
  - A version is a data set for one input data type.
  - A scenario is a collection of versioned input data of various data types and the optimized results.
  - Capability to create and save many study scenarios with minimal data entry.
- Soft and Hard Constraints
  - Hard constraints: physical limits
  - Soft constraints: desirable operating range
- Convenient User Interface

Flowchart for a Scenario Run



Scenario Design Screen

Oroville Local Operation Model - [Scenario Design]

File Options Tools Windows Help

Scenario Design

Scenario

Scenario : Test 1921-1994 | Browse | New | Save

Start Date : Oct 03, 1921 | Num of study years

End Date : Oct 02, 1994 | 73

Create Date : May 28, 2003 05:44 PM

Author : Tung Van Do

Comments : No Notes

Run Status: Optimized short term (hourly) - Incomplete

Input Data	Selected Version
System Configuration	DWR Existing System Configuration
Objective Function Set	Maximize Developmental Value
Inflow year(s)	1921 to 1993
Starting Condition	DWR Test Scenario
Max/Min Level	Oroville Flood Control Curve for 1922
Max/Min Flow	DWR Test Scenario 1922 final 2
Max/Min Generation	Sample generation
Max/Min Generating Flow	Test 1922 final 1
Max/Min Pumpback Flow	DWR Test Scenarios 1922, 1977 & 1983
Max/Min Spill	DWR Test Scenario 1B
Ramping Rate Constraints	Test 1922-1994

Versions of Max/Min Level

Location: Lake Oroville

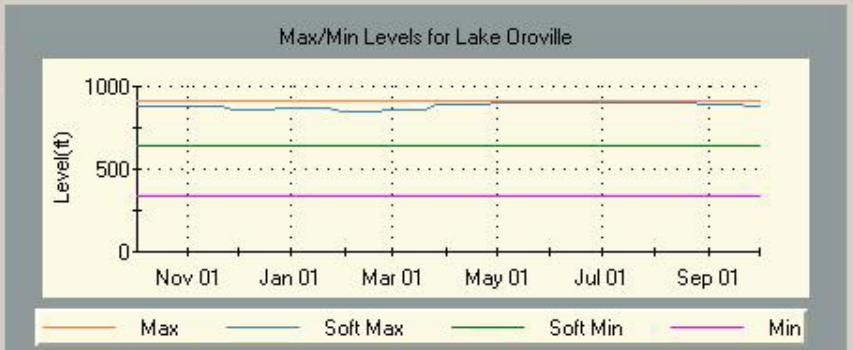
- Default levels
- Oroville Flood Control Curve for 1922
- Oroville Flood Control Curve for 1977
- Oroville Flood Control Curve for 1983

Created Date : May 23, 2003 03:16 PM

Author: Tung Van Do

Comments: No Notes

Select



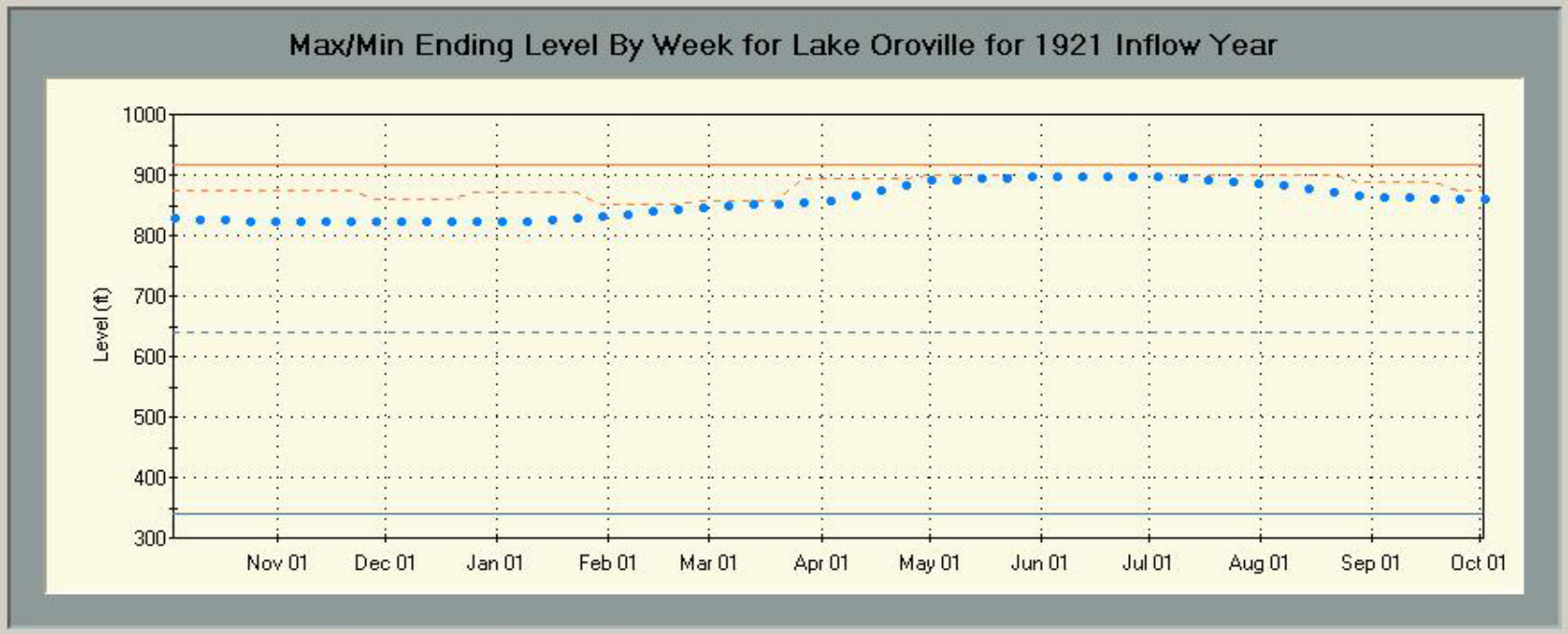
Scenario | Test 1921-1994 | Starting Date | Oct 03, 1921 | Ending Date | Oct 02, 1994 | Scenario Status | Optimized short term (hourly) - Incomplete

Operating Constraints Screen

Oroville Local Operation Model - [Operating Constraints]

File Options Tools Windows Help

Target Flow/Diversions | Target Level | Max/Min Level | Max/Min Flow | Max/Min Generation | Max/Min Generating Flow | Max/Min Pumpback Flow | Max/Min Spill



Legend

- [x] Max
- [x] Soft Max
- [x] Soft Min
- [x] Min
- [x] Target Level

Display

- (•) Week Ending — 1921
- ( ) Hourly — Oct 03

Location

- (•) Lake Oroville
- ( ) Thermalito Div. Pool
- ( ) Thermalito Forebay
- ( ) Thermalito Afterbay

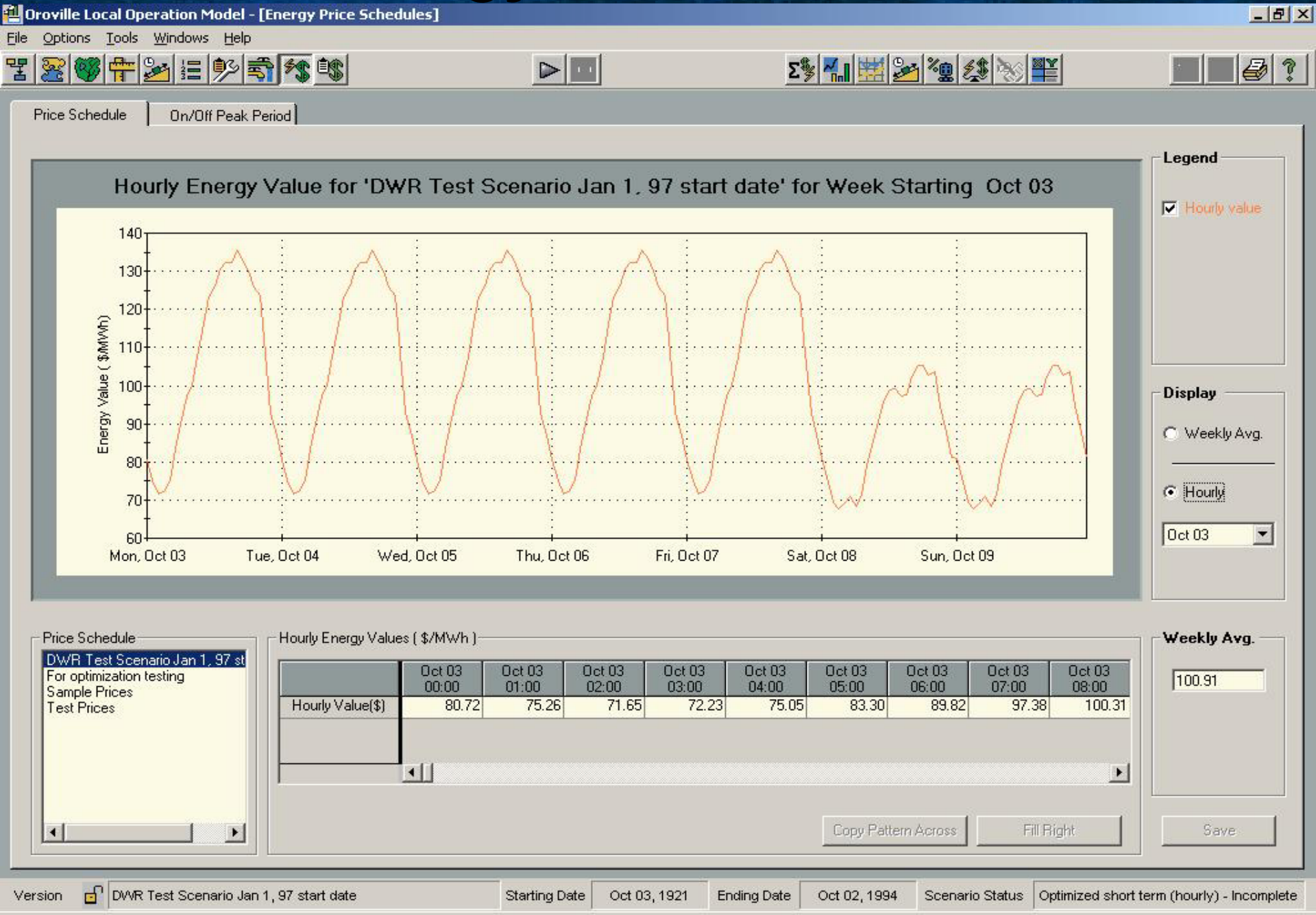
Max/Min Ending Level By Week (ft)

	Use in Model	Ranking	Oct 03	Oct 10	Oct 17	Oct 24	Oct 31	Nov 07	Nov 14
Max Level	☑	n/a	917.00	917.00	917.00	917.00	917.00	917.00	917.00
Soft Max Level	☑	6	875.30	875.30	875.30	875.30	875.30	875.30	875.30
Soft Min Level	☐	n/a	640.00	640.00	640.00	640.00	640.00	640.00	640.00
Min Level	☑	n/a	340.00	340.00	340.00	340.00	340.00	340.00	340.00

Copy Pattern Across | Fill Right | Save

Version | Oroville Flood Control Curve for 1922 | Starting Date | Oct 03, 1921 | Ending Date | Oct 02, 1994 | Scenario Status | Optimized short term (hourly) - Incomplete

Energy Price Screen



Oroville Level Screen

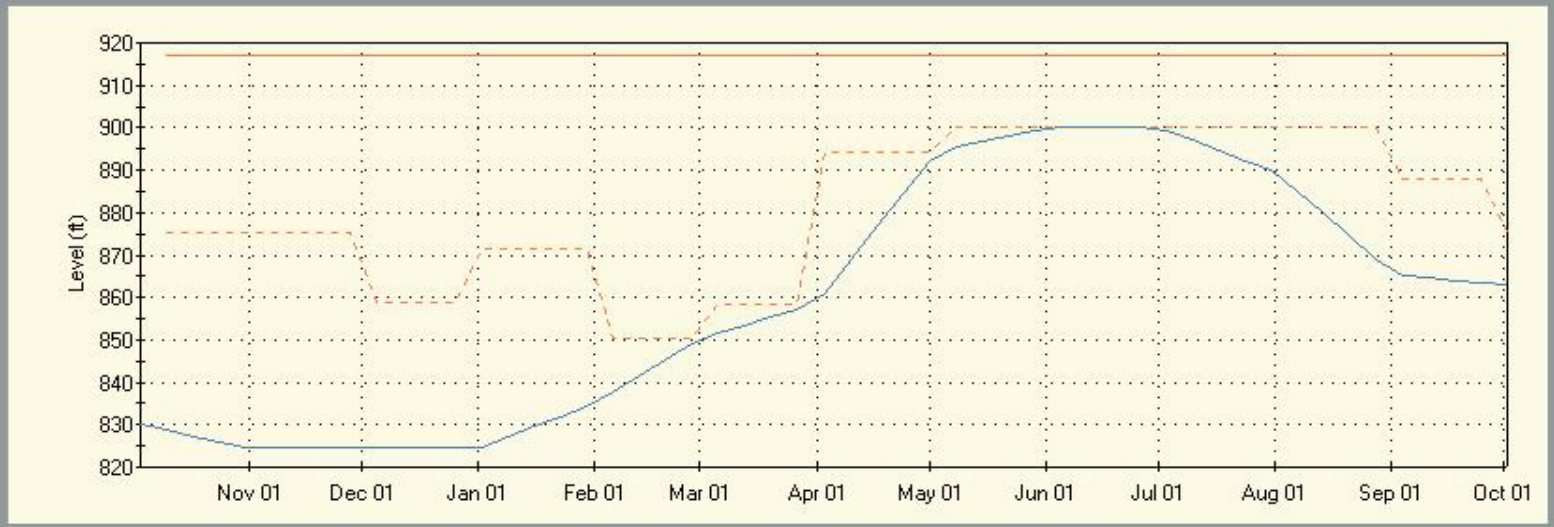
Oroville Local Operation Model - [Results By DataType]

File Options Tools Windows Help

Target Flow/Diversions | Levels | Storage | Local Inflow | Flow | Generation | Generating Flow | Pumpback Flow | Spill | Revenue

Inflow Year: 1921 (Optimized short term (hourly))

Results of Levels for Lake Oroville



Legend

- [x] Max
- [x] Soft Max
- [x] Opt. Value
- [x] Soft Min
- [ ] Min

Display

- (•) Weekly
- ( ) Hourly

Oct 03, 1921

Location

- (•) Lake Oroville
- ( ) Thermalito Div. Pool
- ( ) Thermalito Forebay
- ( ) Thermalito Afterbay

Weekly Starting Level (ft)

	Ranking	Oct 03 1921	Oct 10 1921	Oct 17 1921	Oct 24 1921	Oct 31 1921	Nov 07 1921	Nov 14 1921	Average
Max. Level	n/a	n/a	917.00	917.00	917.00	917.00	917.00	917.00	917.00
Soft Max. Level	6	n/a	875.30	875.30	875.30	875.30	875.30	875.30	881.28
Optimized Level	n/a	830.10	828.74	827.37	825.99	824.61	824.51	824.61	859.97
Soft Min. Level	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Min. Level	n/a	n/a	340.00	340.00	340.00	340.00	340.00	340.00	340.00

Scenario | Test 1921-1994 | Starting Date | Oct 03, 1921 | Ending Date | Oct 02, 1994 | Scenario Status | Optimized short term (hourly) - Incomplete

Pump-back Flow Screen

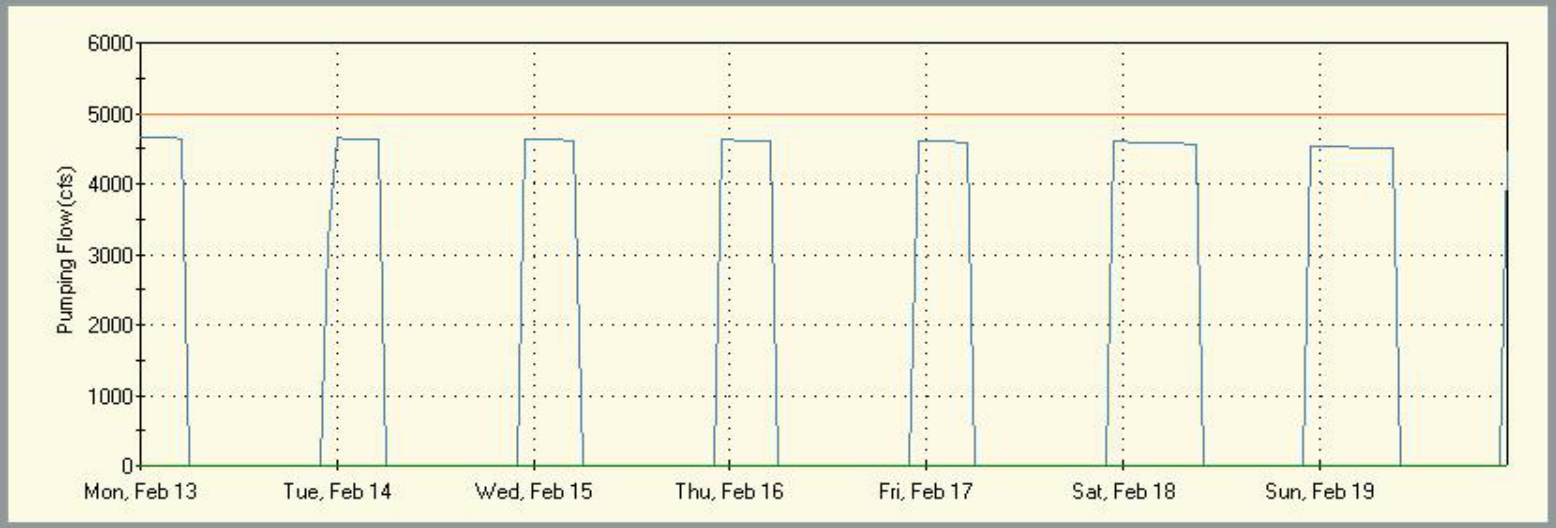
Oroville Local Operation Model - [Results By DataType]

File Options Tools Windows Help

Target Flow/Diversions | Levels | Storage | Local Inflow | Flow | Generation | Generating Flow | Pumpback Flow | Spill | Revenue

Inflow Year: 1921 (Optimized short term (hourly))

Hourly Results of Pumpback Flow for Hyatt Power Plant for Week Starting Feb 13, 1922



Legend

- [x] Max
- [x] Soft Max
- [x] Opt. Value
- [x] Soft Min
- [x] Min

Display

- ( ) Weekly
- (•) Hourly

Feb 13, 1922

Location

- (•) Hyatt Power Plant
- ( ) Thermalito Power Plant

Hourly Results of Pumpback Flow (cfs)

	Ranking	Feb 13 00:00	Feb 13 01:00	Feb 13 02:00	Feb 13 03:00	Feb 13 04:00	Feb 13 05:00	Feb 13 06:00	Average
Max. Pumpback	n/a	5000	5000	5000	5000	5000	5000	5000	5000
Soft Max. Pumpback	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Optimized Pumpback	n/a	4663	4659	4655	4651	4647	4644	0.0	1550
Soft Min. Pumpback	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Min. Pumpback	n/a	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Scenario | Test 1921-1994 | Starting Date | Oct 03, 1921 | Ending Date | Oct 02, 1994 | Scenario Status | Optimized short term (hourly) - Incomplete

Turbine Results Screen

Oroville Local Operation Model - [Turbine Results]

File Options Tools Windows Help

Turbine Results

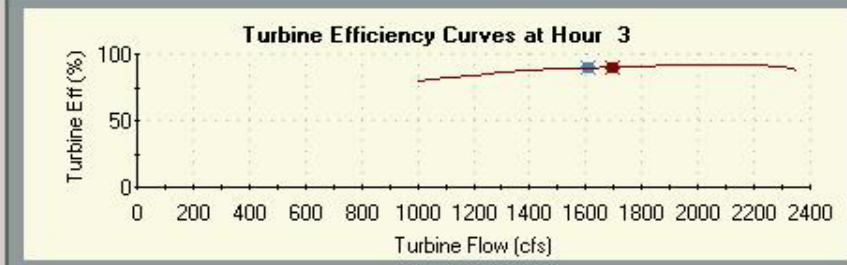
Generation (MWh) at Hyatt Power Plant for Tuesday, Oct 4, 1921

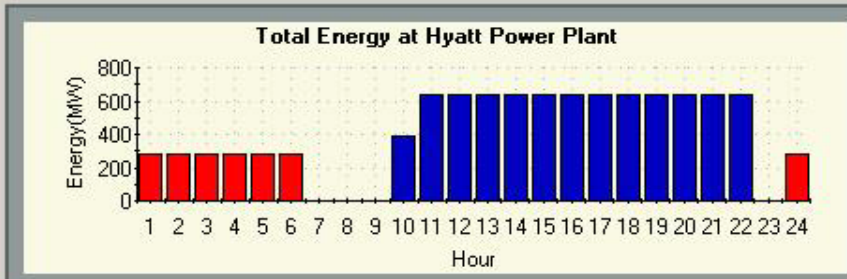
Inflow Year: 1921 (Optimized short term (hourly))

Energy | Flow | Efficiency

Hour	Unit 1	Unit 2	Unit 3	Unit 4	Total
00 - 01	0.00	96.60	0.00	96.60	285.1
01 - 02	0.00	91.98	0.00	96.58	285.2
02 - 03	0.00	92.05	0.00	96.57	285.2
03 - 04	0.00	92.11	0.00	96.55	285.2
04 - 05	0.00	96.54	0.00	92.18	285.3
05 - 06	0.00	96.52	0.00	92.25	285.3
06 - 07	0.00	0.00	0.00	0.00	0.00
07 - 08	0.00	0.00	0.00	0.00	0.00
08 - 09	0.00	0.00	0.00	0.00	0.00
09 - 10	129.7	0.00	129.7	0.00	389.1
10 - 11	129.1	21.57	129.1	116.5	641.9
11 - 12	129.1	116.5	129.1	116.5	641.9
12 - 13	129.0	21.71	129.0	116.5	641.8
13 - 14	129.0	21.77	129.0	116.5	641.8
14 - 15	129.0	21.84	129.0	116.5	641.8
15 - 16	129.0	21.91	129.0	116.5	641.8
16 - 17	129.0	116.4	129.0	21.98	641.8
17 - 18	129.0	116.4	129.0	116.4	641.8
18 - 19	128.9	116.4	128.9	22.12	641.8
19 - 20	128.9	22.19	128.9	116.4	641.8
20 - 21	128.9	116.4	128.9	22.26	641.8
21 - 22	128.9	116.4	128.9	116.4	641.8
22 - 23	0.00	0.00	0.00	0.00	0.00
23 - 24	0.00	96.79	0.00	96.79	284.7
Total	1,678	829.6	1,678	1,115	8,091

Generating | Pumping





Location

- (•) Hyatt Power Plant
- ( ) Thermalito DD Plant
- ( ) Thermalito Power Plant

Day

Week Starting: Oct 03, 1921

- ( ) Monday
- (•) Tuesday
- ( ) Wednesday
- ( ) Thursday
- ( ) Friday
- ( ) Saturday
- ( ) Sunday

Version | DWR Test Scenario Jan 1, 97 start date | Starting Date | Oct 03, 1921 | Ending Date | Oct 02, 1994 | Scenario Status | Optimized short term (hourly) - Incomplete

HYDROPS Q&A

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